

# Ballistic Missile Defense Technology Master Plan (TMRP)



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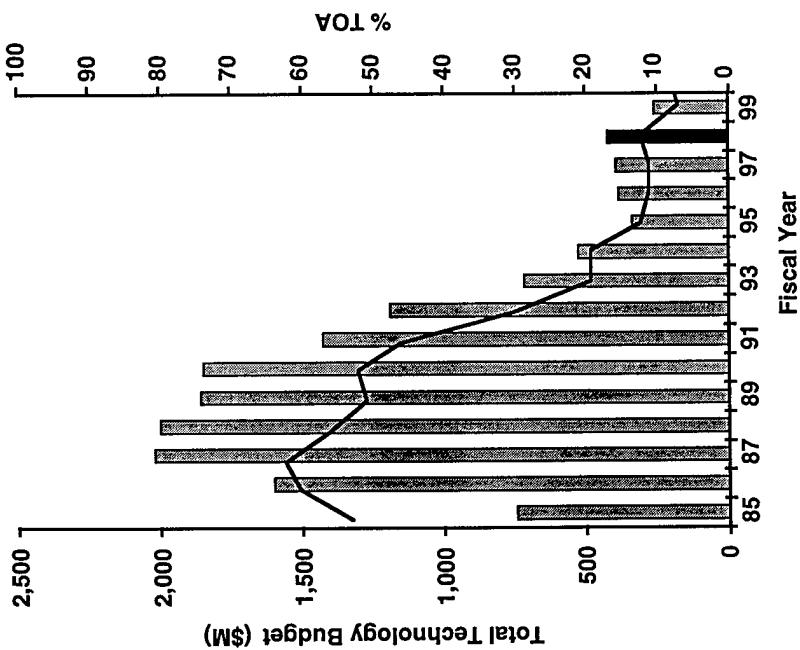
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# BMDO TECHNOLOGY FUNDING



- SDI Focus In Past Years Was On Research, Development And Demonstration Of Fundamental Technologies
- The Shift In Program Focus To The Development And Fielding Of National And Theater Defenses Resulted In Limited Resources For Continued Technology Development
- Reduction In Resources From ≈ 60% To 7% TOA Presents US With Both A Challenge And An Opportunity





## RATIONALE FOR TECHNOLOGY MASTER PLAN

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- End Decline In BMDO's Technology Budget
  - Threatened Ability To Keep Pace With Threat
  - 7% TOA In FY 99 With Demands For Further Reductions
- Maximize Funding Leverage By Using Service And Other Agencies' Technology Programs Wherever Possible
- Document How BMDO Technology Supports Its Major Defense Acquisition Programs (MDAPs)
- Improve Missile Defense Community Participation In BMDO Technology Program

# 1997 TMP CONTENTS

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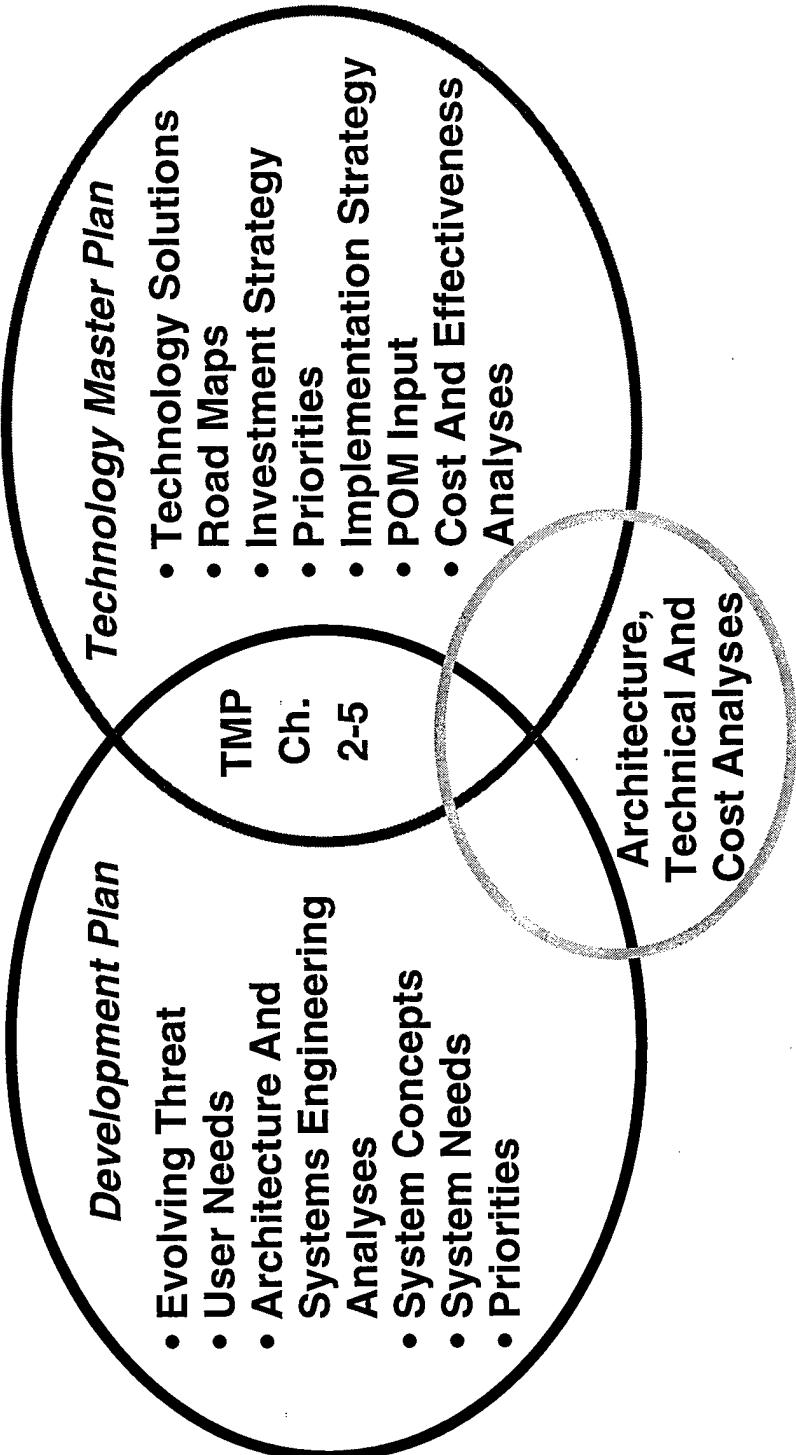


- **Missile Defense Architectures**
  - TMD, NMD, Cruise Missile
- **BMD Drivers**
  - Threat, MDAP Support, Resource Constraints
- **Military Needs**
  - Weapon System Effectiveness, Utility, Availability
- **Technology Needs**
  - Interceptor, Surveillance, BM/C<sup>4</sup>I, Directed Energy
- **Technology Solutions**
  - Technology Area Plans And Road Maps For Each Technology Needs Area
- **Investment Strategy**
  - Funding For Each Program By Year In Accordance With Director's Guidance

# BMDO PLANNING FOR TECHNOLOGY INVESTMENT

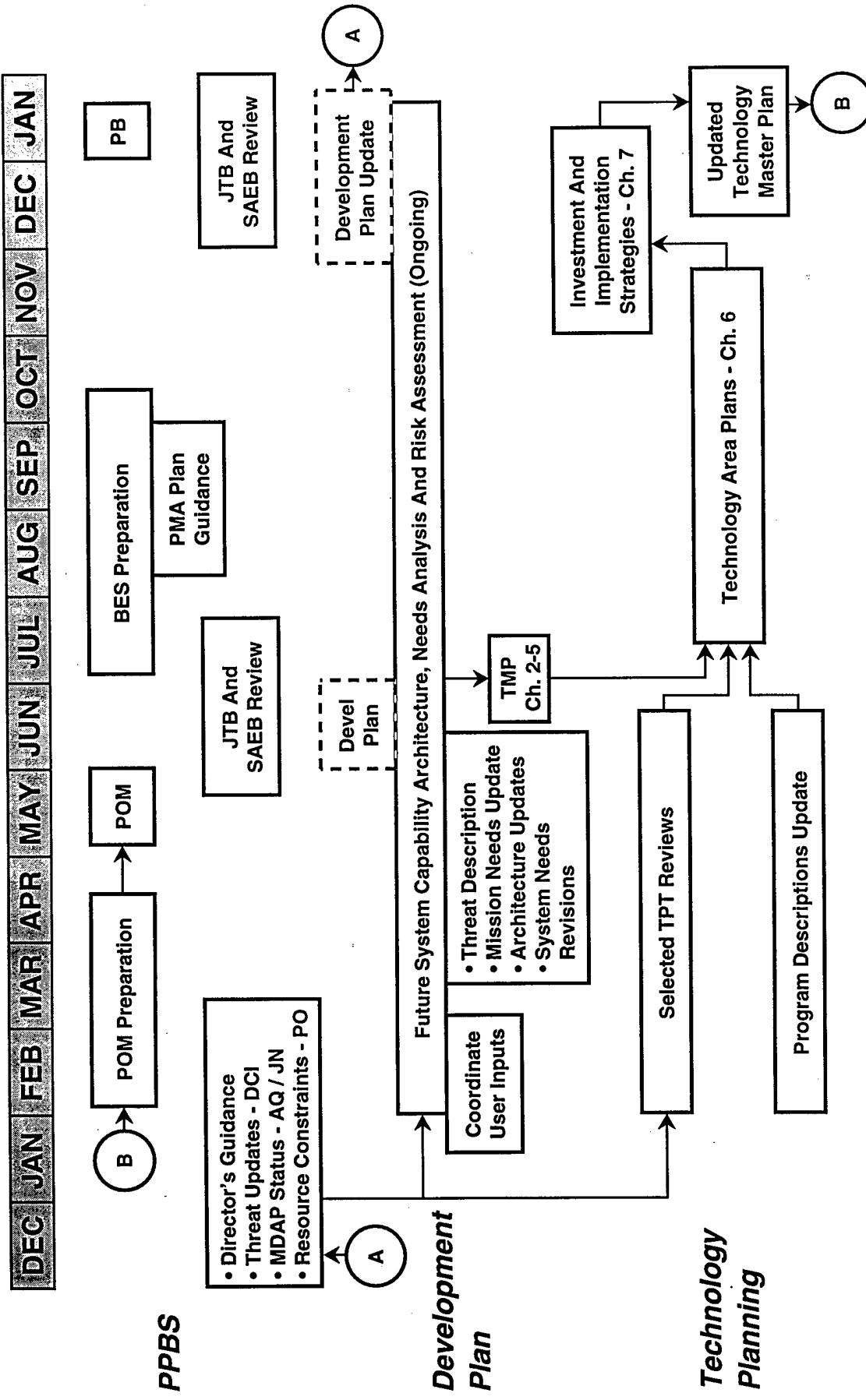


*The Development Planning Process Provides BMDO's System Needs For Technology And Basis For Investment*



**The Technology Master Plan Defines BMDO's Investment And Approach To Obtaining The “Needed” Technology**

ANNUAL TMP PROCESS





# TECHNOLOGY PLANNING TEAMS (TPT)

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- TPT Areas
  - Interceptors
  - Surveillance
  - BM/C<sup>4</sup>I\*
  - Directed Energy\*
- Responsibilities
  - Identify Programs That Meet Technology Needs
  - Develop Technology Area Plans
  - Tailor Or Leverage Existing Programs Where Possible, Otherwise Recommend New Starts
  - Produce Technology Road Maps
  - Prioritize Technology Programs

\* Formed 1998

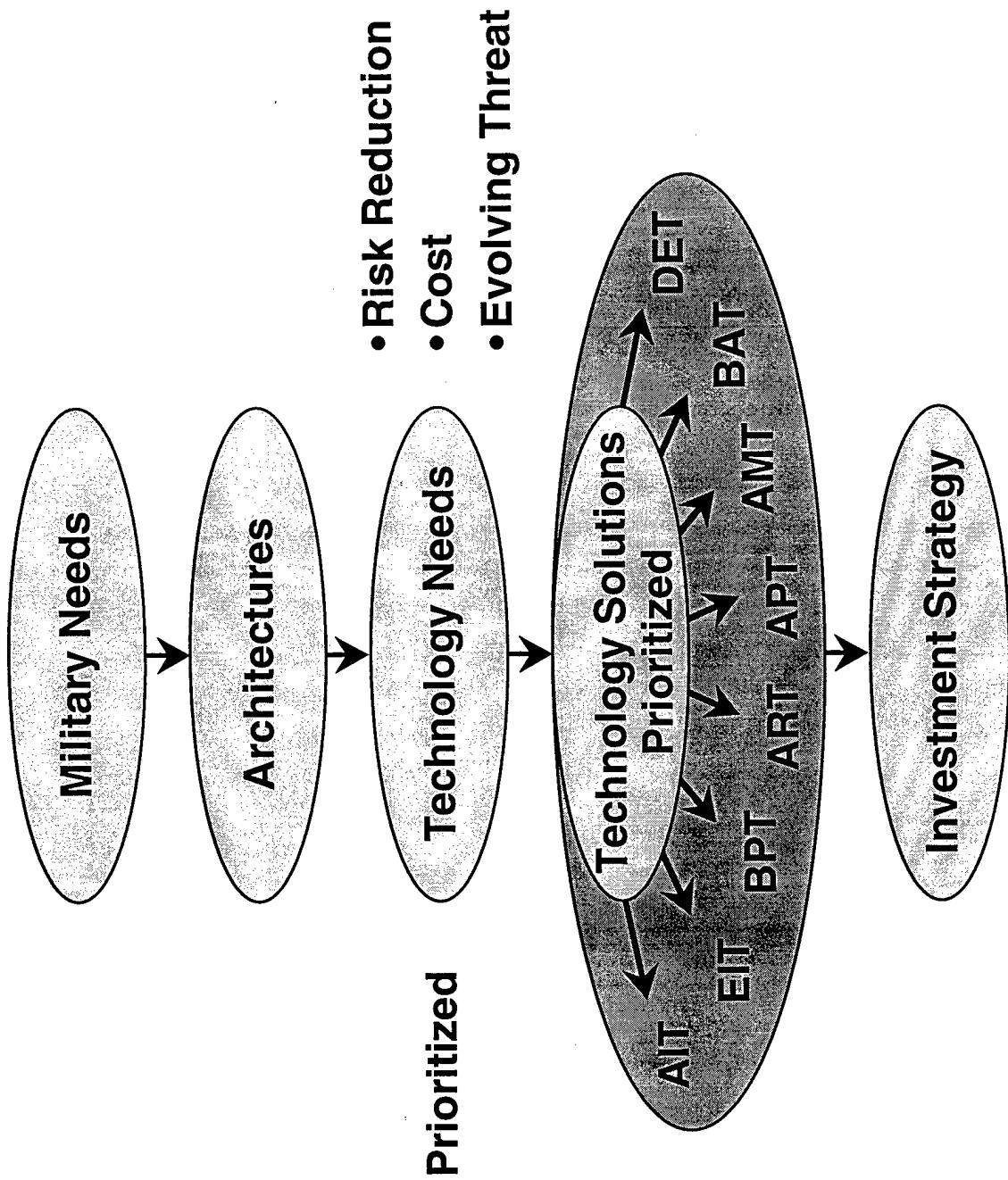
# TMP TECHNOLOGY AREAS

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- Atmospheric Interceptor Technology (AIT)
- Exoatmospheric Interceptor Technology (EIT)
- Boost Phase Intercept (BPI)
- Advanced Radar Technology (ART)
- Advanced Passive Technology (APT)
- Advanced Mission Technology (AMT)
- BM/C4I Advanced Technology (BAT)
- Directed Energy Technology (DET)

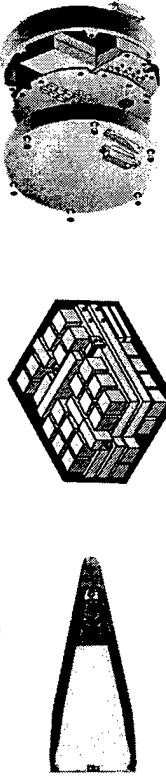
# 1998 TMP FORMAT





# INTERCEPTOR INTEGRATED TECHNOLOGY PROGRAMS

## *Atmospheric Interceptor Technology*



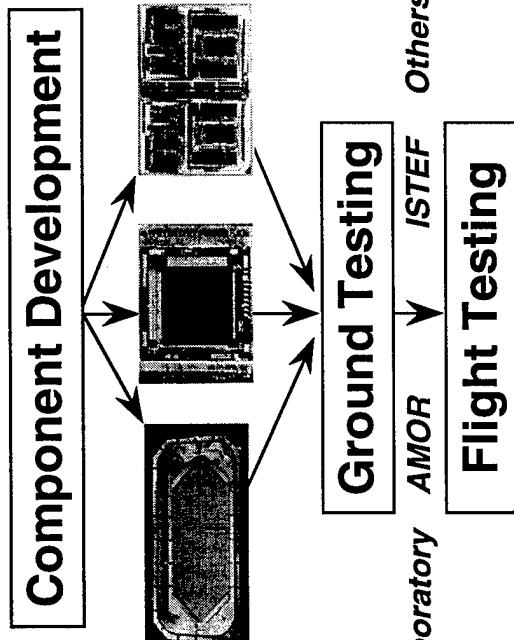
Shroud  
Ka-band Transmitter

Cooled Window

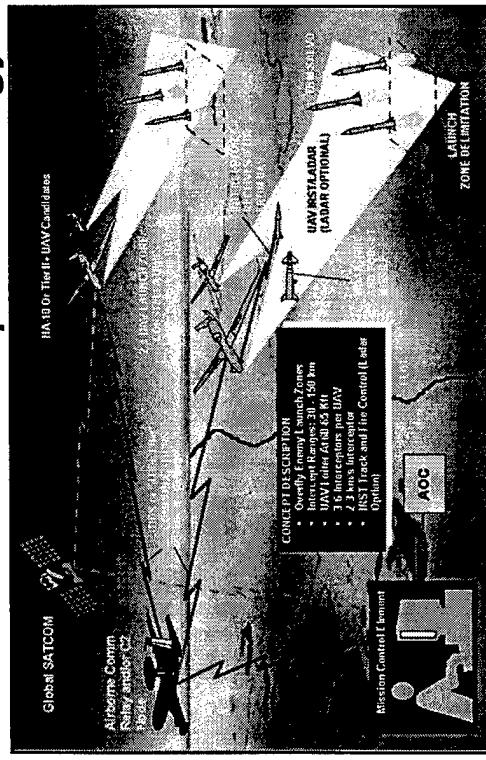
Strap Down IR Seeker

Advanced GNC Avionics

## *Exoatmospheric Interceptor Technology*



## *Boost Phase Intercept Technology*



- The BMDO Technology Master Plan (TMP) Is The Foundation For Restructured Interceptor Technology Programs
- Interceptor Technologies Are Better Tied To MDAP Needs

## *New Technologies Will*

- Respond To Evolving Threat
- Enhance Current MDAP Performance
- Improve Affordability / Reliability



## INTERCEPTOR FOCUS AREAS

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- Atmospheric Interceptor Technology (AIT)
  - Advanced Lower Tier Interceptor Technology
  - Endoatmospheric Seekers, Windows, Interceptor Agility, Safe DACS, Optimal Guidance, Estimation Of Target Maneuvers
- Exoatmospheric Interceptor Technology (EIT)
  - Advanced Technologies For NMD And TMD Upper Tier
  - Multicolor Focal Plane Arrays, Laser Radar, Advanced Processors, Algorithms
- Boost Phase Intercept (BPI)
  - Target State Estimation Sensors And Algorithms, Missile Plume To Hard Body Handover



# AIT TECHNOLOGY CROSSWALK

TMP Identified Needs	AIT Technology Solutions Satisfy TMP Identified Needs For The MDAPS				
	Potential Users	Navy Area	PAC-3	MEADS	THAAD
Discrimination	X	X	X	X	X
Interceptor Agility	X	X	X	X	X
Seeker Accuracy	X	X	X	X	X
Affordability / Productibility	X	X	X	X	X
Information Technology	X	X	X	X	X
Other Support (Lethality, M&S)	X	X	X	X	X
Advanced GNC Processors*	X	X	X	X	X
Dual Mode IR / RF Seekers	X	X	X	X	X
Strap Down Seeker With Image Motion Stabilization	X	X	X	X	X
Solid-state Ka-Band RF Seeker	X	X	X	X	X
High Thrust Nontoxic DACS	X	X	X	X	X
Controllable, TVC Axial Propulsion	X	X	X	X	X
Advanced GNC Algorithms	X	X	X	X	X
Lightweight Composite Structures (Comparable Cost / Risk)	X	X	X	X	X
Advanced Windows	X	X	X	X	X
Aim Point Selection Algorithms	X	X	X	X	X
Flight Software Development Methodology	X	X	X	X	X
Advanced Nonthermal Battery*	X	X	X	X	X

\* May Also Apply To Upper Tier Programs



# EIT TECHNOLOGY CROSSWALK

EIT Identified Needs	Potential Users				
	NTW	GBI	THAAD	NW	Other Support (Lethality, M&S)
<b>EIT Technology Solutions Satisfy TMDP Identified Needs For The MDAPs</b>					
Discrimination	X	X	X	X	X
Agility	X	X	X	X	X
Seeker Accuracy	X	X	X	X	X
Affordability / Productivity	X	X	X	X	X
Information Technology	X	X	X	X	X
Other Support (Lethality, M&S)	X	X	X	X	X
<b>EIT Technology Solutions</b>					
2-color LWIR FPA (3-4-color Desirable)	X	X	X	X	X
Imaging Laser Radar	X	X	X	X	X
Large Format Array Productibility And Operability	X	X	X	X	X
ROIC / On-FPA Processing*	X	X	X	X	X
TOM Correlation	X	X	X	X	X
Fusion Algorithms	X	X	X	X	X
Multitarget Tracking Algorithms	X	X	X	X	X
Aim Point Selection Algorithms	X	X	X	X	X
High Performance, Lightweight Processor*	X	X	X	X	X
Small 20 / 44 GHz UL / DL Transceiver*	X	X	X	X	X
Beyond LOS Cooperative Engagement	X	X	X	X	X
High Efficiency, Long Shelf Life Batteries	X	X	X	X	X
All Reflective Optics	X	X	X	X	X
Lightweight Structures – Cost And Risk Comparison To Aluminum	X	X	X	X	X
Lethality – Code Validation And Data Collect*	X	X	X	X	X
Lethality – Kill Enhancers*	X	X	X	X	X
Radiation Hardening Of Advanced Components	X	X	X	X	X

\*May Also Apply To Lower Tier Programs

# BIT INTERCEPTOR TECHNOLOGY CROSSWALK

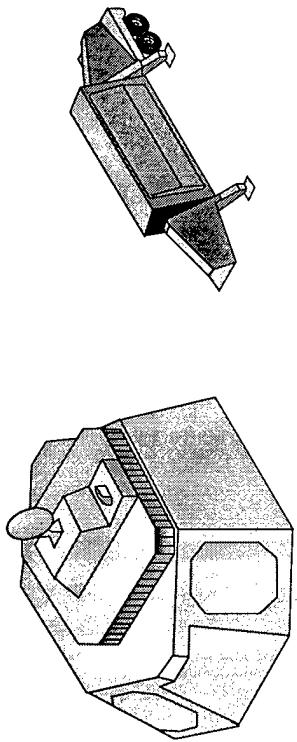


TMP Identified Needs	BIT Technology Solutions		Potential Users
	Address TMP Identified Needs For UAV BPI Hedge Capability With Contributions To MDAP Upgrades	UAV BPI	
Countercountermasures		Air Superiority Missile Lower Tier MDAPs	
Interceptor Agility		Upper Tier MDAPs	
Seeker Accuracy	X X X X		
Affordability / Productivity	X X X X		
Information Technology			
Other Support (Lethality, M8s)			
Maneuverable, Thrust-on-demand Boosters	X	X X	X X
Nontoxic, High Mass Fraction Liquid DACS	X	X X	X X
High Mass Fraction Axial Stage Booster	X	X X	X X
Lightweight, Low-cost Visible KKV Seeker	X		
Dual Mode Seeker With Active Ranging (LADAR / RF)	X	X X	X X
Advanced BPI GNC Algorithms (Commit Through Endgame)	X	X X	X X
Plume-to-hardbody Handover Algorithms	X	X X	X X
Boost Phase Aim Point Selection Algorithms	X	X X	X X
PIP Generation Algorithms	X	X X	X X
Advanced Thermal Materials (Structure / Windows)	X	X X	X X
All Aspect Commit Interceptor - Aircraft Integration	X	X X	X X
Lightweight IFTU Communications Subsystem	X	X X	X X
End-to-end Design Tools, HWIL Test Beds	X	X X	X X

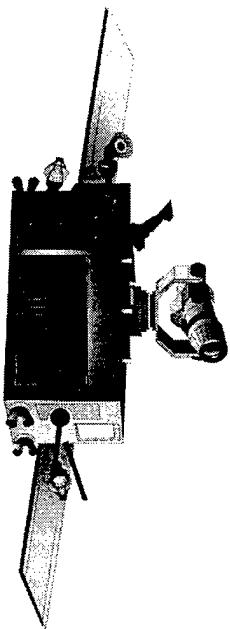


# SURVEILLANCE INTEGRATED TECHNOLOGY PROGRAMS

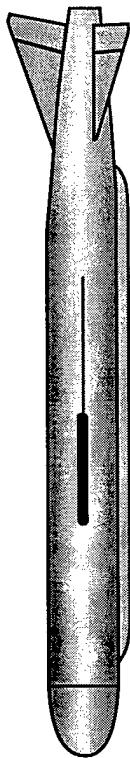
## *Advanced Radar Technology (ART)*



## *Advanced Passive Technology (APT)*



## *Advanced Mission Technology (AMT)*



- The BMDO Technology Master Plan (TMP) Is The Foundation For Surveillance Technology Programs

- Surveillance Technologies Are Directly Tied To MDAP Needs
- Technology Efforts Will
  - Meet Current MDAP Requirements
  - Respond To Evolving Threat
  - Improve Affordability / Reliability



## SURVEILLANCE FOCUS AREAS

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- Advanced Radar Technology (ART)
  - Increased Power Aperture And Beam Agility, Enhanced Waveform Design
  - Low Cost T / R Modules, Improved Processors, Advanced Algorithms
- Advanced Passive Technology (APT)
  - Advanced Components For Satellite Surveillance, Acquisition, Track, Discrimination, Kill Assessment (SATDKA)
  - Improved FPA Uniformity, Longer Wavelengths, Optics Cleaning, Cryocoolers, Radiation Hardened Electronics
- Advanced Mission Technology (AMT)
  - SATDKA Functions For Cruise Missile Threat



# ART TECHNOLOGY CROSSWALK

TMP Identified Needs	ART Technology Solutions Satisfy TMP Identified Needs For The MDAPS					Potential Users
	NTW	THAAD	Navy Area	NMD GBR		
<b>ART Technologies</b>						
Surveillance	X	X	X	X	X	X
Acquisition	X	X	X	X	X	X
Track	X	X	X	X	X	X
Discrimination	X	X	X	X	X	X
Kill Assessment	X	X	X	X	X	X
Productability / Affordability	X	X	X	X	X	X

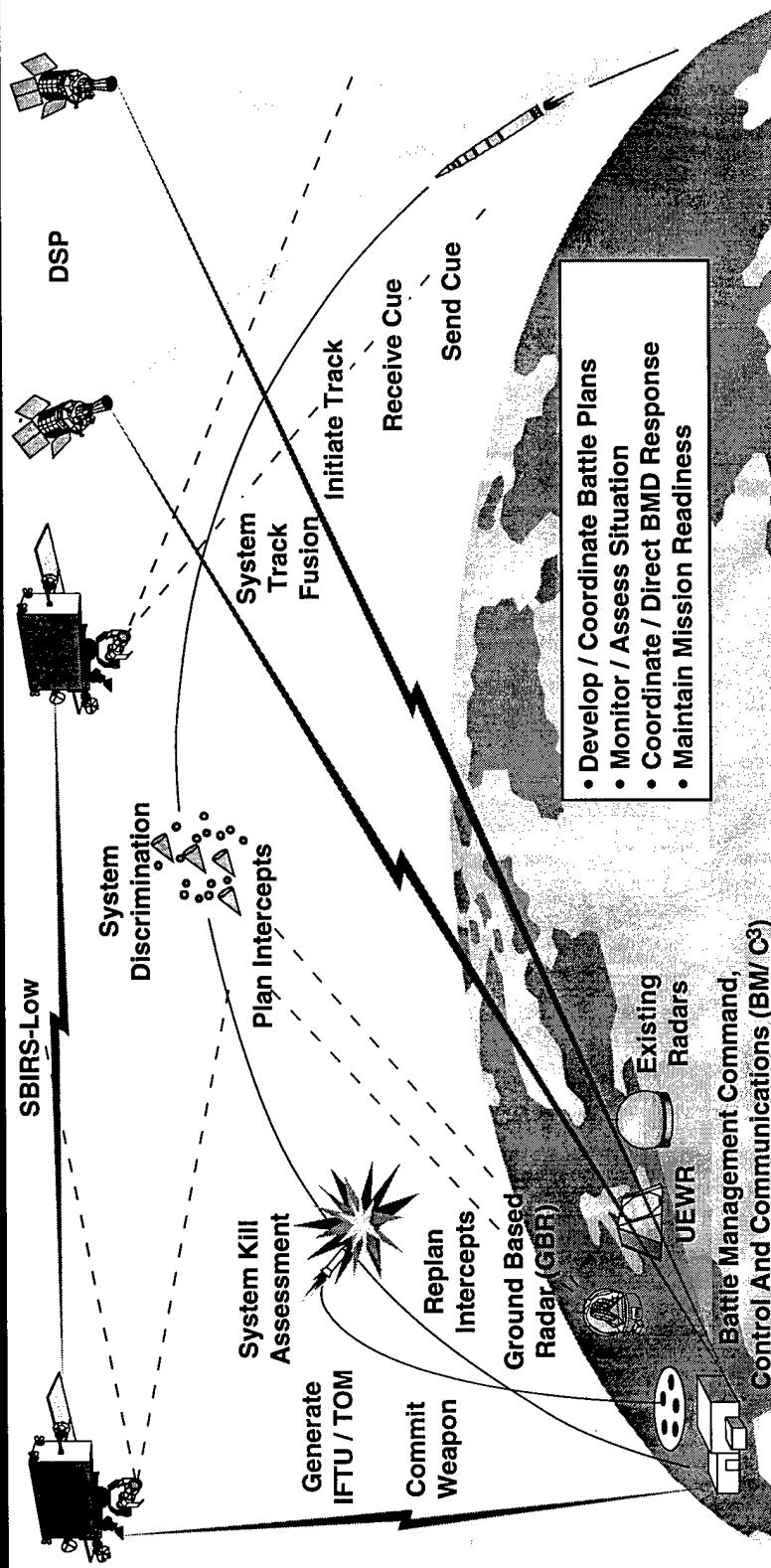
# APT TECHNOLOGY CROSSWALK



APT Technology Solutions Satisfy TMAP Identified Needs For The MDAPs		Potential Users			
TMAP Identified Needs	APT Technologies	THAAD	NMD SBIRS	Navy Area	NTW
Surveillance	X X X X X X	X X X X X X	X X X X X X	X X X X X X	X X X X X X
Acquisition	X X X X X X	X X X X X X	X X X X X X	X X X X X X	X X X X X X
Track	X X X X X X	X X X X X X	X X X X X X	X X X X X X	X X X X X X
Discrimination	X X X X X X	X X X X X X	X X X X X X	X X X X X X	X X X X X X
Kill Assessment	X X X X X X	X X X X X X	X X X X X X	X X X X X X	X X X X X X
Affordability / Productibility	X X X X X X	X X X X X X	X X X X X X	X X X X X X	X X X X X X



# BM/C4I ADVANCED TECHNOLOGY (BAT)



## Defense Against Strategic Ballistic Missiles

- The BMDO Technology Master Plan (TMP) Is The Foundation For Restructured BM/C4I Technology Programs
- BM/C4I Technologies Are Tied To MDAP Needs
- New Technologies Will
  - Improve Battle Management In Response To An Evolving NMD / TAMD Threat
  - Enhance Current MDAP Performance And Improve Affordability / Reliability
  - Address Advanced Mission Threat Battle Management

# **BM/C<sup>4</sup>I FOCUS**

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- **BM/C<sup>4</sup>I Advanced Technology (BAT)**
  - Use Open Systems Standards, Leverage Communications Infrastructure
  - Battle Management Technology, Situation Awareness, Kill Assessment, Evaluation Tools

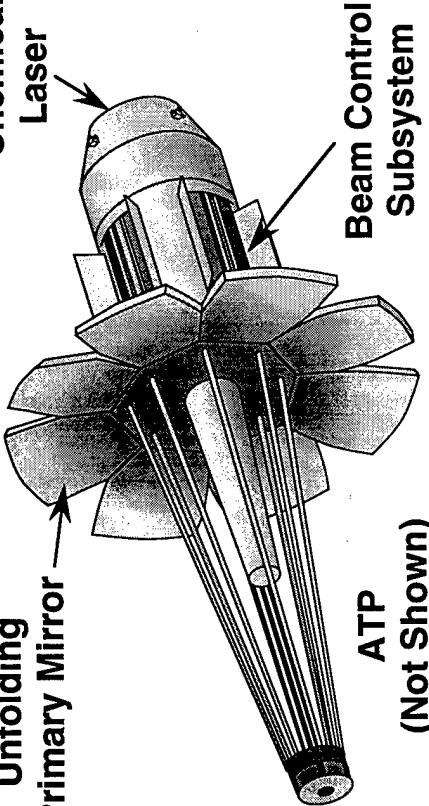


# BM/C<sup>4</sup>I TECHNOLOGY CROSSWALK

Satisfy TMP Identified Needs For The MDAPs		Potential Users	
TMP Identified Needs	Evaluation Tools	NMD	FoS
Comms Infrastructure	GPS / IFTU Broadcast	X	X
Battle Management	Miniaturized Wideband SATCOM	X	X
Situation Awareness	Passive Millimeter Radiometry	X	X
Kill Assessment	Intelligent Bandwidth Imaging	X	X
	Wideband Cloud Imaging	X	X
	Impact Signature Collection / Research	X	X
	Cooperative Engagement Capability Range Extension	X	X
	Multiple Sensor Fusion	X	X
	UEWR / XBR Fusion	X	
	Distributed UHF Propagation Environment	X	
	Distributed Tracking	X	
	UHF Doppler Discrimination	X	
	Surveillance Test Bed Network Models	X	
	Adaptive Planning	X	X



# SPACE BASED LASER (SBL) SYSTEM

Mission	Readiness Demonstrator (RD)
<p><b>Notional Space Vehicle</b></p> <p>Chemical Laser</p> <p>Unfolding Primary Mirror</p>  <p>Beam Control Subsystem</p> <p>ATP (Not Shown)</p>	<ul style="list-style-type: none"><li>• Continuous, Global Coverage, Boost Phase Intercept For NMD And TMD</li><li>• Space Control</li><li>• Other Futuristic Applications</li></ul>
Development Issues	Operational System
	<ul style="list-style-type: none"><li>• Policy / Treaty</li><li>• Cost</li><li>• Launch Vehicle (Size / Weight)</li><li>• Integration Into NMD / TMD</li><li>• Alternative System Concepts</li><li>• Advanced Technology</li></ul>

# DIRECTED ENERGY FOCUS

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- Directed Energy Technology (DET)
  - Integrated Technology For Space Based Laser Readiness Demonstrator
  - Precision Pointing, Wave Front Sensing Adaptive Optics, Advanced Beam Generation

# IMPLEMENTATION STRATEGY



- Based On Director's Guidance To Allocate 10% (Minimum) – 12% (Goal) Of BMDO Total Obligational Authority To Technology Development
  - Includes Set Asides (e.g., SBL Readiness Demonstrator, SBIR)
- Consistent With Technology Priorities
  - Solution Or Mitigation Of A Critical Challenge
  - Cost Reduction
  - Multiple Potential Applications
  - Breakthrough Technologies



## THE WAY AHEAD

- TMP Updated Annually To Keep Technology Program Current With Threat, Mission And MDAP Changes
  - 1997 TMP Is Complete. 1998 TMP Is In Work
- 1998 Changes
  - Added Two New TPTs (BM/C4I And DET)
  - Include MANTEC
  - Include Industry Programs
  - Include Allied Programs
  - Improve TMP Readability
- Engineering Analysis Team Formed
  - Derive Technology Needs
  - Quantify Performance And Cost Benefits Of Technology Solutions

# SUMMARY



- BMDO TMP Is The Vehicle For Implementing Director's Guidance For Technology
  - Maintain U.S. Technical Superiority In Missile Defense
  - Relate BMDO Technology To MDAP Needs And Operational Capabilities
  - Allocate A Goal Of 12% Of TOA, But Not Less Than 10% For BMDO Technology Program
  - Maximize Participation Of Missile Defense Community In BMDO Technology Program



# 1997 TMP TAXONOMIES

- **Interceptors**
  - Discrimination, Agility, Accuracy, Information Technology, Affordability And Other Supporting Technologies
- **Surveillance**
  - Surveillance, Acquisition, Track, Discrimination, Kill Assessment, Affordability, Other Supporting Technologies
- **BM/C<sup>4</sup>I**
  - Communications, Battle Management, Situation Awareness, Kill Assessment, And Evaluation Tools
- **Directed Energy**
  - Space Based Laser Readiness Demonstrator